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and Predation**

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ABSTRACT

Incentives to Grow: Multimarket Firms and Predation

by Rainer Nitsche*

Network industries with low sunk costs have been popular examples for the theory of contestable markets and spatial competition models. We argue that, due to the multimarket nature of operations, theories of predation are more relevant to explain strategic behaviour. Building on well established reputation models our contribution is threefold. First, we use a more realistic sequencing of the game and strengthen the entry deterrence result. Second, we show that rational multimarket firms may use (the threat of) predatory entry to expand. Third, we allow strategic interaction of two multimarket firms and find that multimarket firms do not "attack" each other.

ZUSAMMENFASSUNG

Expansionsanreize: Multimarktunternehmen und Verdrängungsstrategien

Netzwerkindustrien mit geringen versunkenen Kosten dienen häufig als Anwendungsfelder für die Theorie der bestreitbaren Märkte und für Modelle des räumlichen Wettbewerbs. In der vorliegenden Arbeit wird argumentiert, daß aufgrund der Multimarktnatur dieser Branchen Theorien des Verdrängungsverhaltens eine relevantere Erklärung des strategischen Verhaltens liefern. Auf der Basis der etablierten Reputationsmodelle werden drei Neuerungen entwickelt. Erstens wird eine Spielsequenz eingeführt, die nicht nur realistischer ist als die herkömmliche Modellierung, sondern auch zu einer plausibleren Prognose führt: Verhinderung von Markteintritt in sämtlichen Märkten. Zweitens wird gezeigt, daß rationale Multimarktunternehmen die Drohung eines Markteintritts mit anschließender Verdrängung des alteingesessenen „Mittelständlers“ (Einmarktunternehmens) im Rahmen einer Expansionsstrategie glaubhaft nutzen können. Schließlich wird, drittens, die strategische Interaktion von zwei Multimarktunternehmen untersucht. Es zeigt sich, daß sie auf gegenseitigen „Angriff“ verzichten und nicht in einen Markt des jeweils anderen Multimarkt-Wettbewerbers eindringen.

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1 Introduction

Stories about markets can have an important impact on economic policy. In 1984 the British Government proclaimed in its White Paper on buses that the bus market was “highly contestable” (Department of Transport 1984). Two years later the local bus market outside London was completely deregulated. Critiques of deregulation used the framework of a “circular city” when analysing local bus markets (e.g. Evans 1987). They argued that deregulation would lower welfare due to excessive entry. Similar arguments for and against liberalisation have been put forward for other network industries like airlines or postal services. These industries share one characteristic which has dominated applied economic analysis and strongly influenced policy advice: sunk costs are low. That is, building up or closing down operations in these markets is cheap compared to other network industries. This motivated the assumption that entry and exit are (almost) costless which is required for contestability as well as the circular city framework. In fact the analysis of the existence of sunk costs has become the key criterion for motivating deregulation and liberalisation.

We believe that a richer and more careful comparison of stylised facts with the assumptions and predictions of these models reveals that their explanatory value for the particular network industries is limited. Take again the British bus industry. We claim that apart from low sunk costs the following stylised facts have empirical substance:¹ (1) Competition is localised. A bus service may compete to some extent with a service that operates in the same corridor. Certainly, it does not compete with a service in another area. (2) Fares, frequencies, and scheduling of services can be varied without significant time lags. (3) Economies of scale and scope cannot explain competitive advantages of large firms. In its plentiful investigations into the bus industry, the Monopolies and Mergers Commission could not find any systematic unit cost advantage for large operators. (4) Industry concentration has increased significantly since deregulation. In the period from 1989 to 1999 the four firm concentration ratio (turnover) went up from 12% to 59%.² (5) Competition on the road was a rare event and where it occurred the firms involved typically did not cover their costs, since incumbents did not relocate or reschedule their services. (6) Large firms almost never entered markets of other large firms.

¹The stylised facts can be derived from the reports of the competition authorities (e.g. MMC 1995) and research reports which were commissioned by the British Government (e.g. Balcombe et al. 1992).

²Market share (turnover) of the four largest bus operators (holdings) in Great Britain (see Monopolies and Mergers Commission 1995 and TAS 2000). Local concentration is much higher since, first, these firms do not operate in all local markets and, second, they do not operate in the same set of markets.

These facts cause problems for the prevailing models of the industry. The fact (2) that fares and service levels can be varied without significant lags does not fit the theory of contestable markets. According to this theory, monopolists behave as if they are facing active competition since they fear that otherwise a potential entrant will enter, price its service slightly below the prevailing level of the incumbent, earn profits until the incumbent reacts and then exit the market (Baumol, Panzar and Willig 1982). It is well established that even with almost no sunk costs the threat of hit and run entry is not credible if incumbents can react to entry with (almost) no lag, which is what we observe in the industry (Reynolds and Schwartz 1983, Shepherd 1984).

The results of the circular city model are driven by the following arguments. In deregulated markets entry and competition would cause incumbents to reschedule their services (to make room for the entrant) until profits in the industry are zero and no further entry occurs. Given that entrants do not take into account the business stealing effect that their entry has on rivals, too many buses will chase too few passengers. Hence, although prices reflect costs, welfare is worse than in a perfectly regulated benchmark since too many buses imply too high fixed costs (Salop 1979, Evans 1987). Facts (4) and (5) contradict the assumptions of this model. Entry was not often observed and when it was observed the incumbent typically did not reschedule (often the frequency of services was increased) and both firms lost money until one of the rivals left the market or was taken-over by the other.

We believe that neither approach performs well in explaining the economics of the market, which captures the essence of market evolution. Rather, we suggest a predation model, claim that it has more explanatory value and try to give some formal underpinning.³ Emphasising stylised fact (1) that competition is localised we attempt to show how multimarket firms may benefit from operating in several distinct markets. This explains why we observe increasing concentration (4) although this cannot be explained by economies of scale and scope (3) or barriers to entry due to sunk costs.

The basic intuition of our arguments is well established. Milgrom and

³Although to our knowledge no formal explanation of predation in the bus industry exist, there is previous work that has highlighted the potential importance of predation. First, in its various competition cases both British competition authorities, MMC and OFT, found evidence of predation in the bus industry. Second, Dodgson et al. (1988) pointed to the importance of the theory of predation for the bus industry and later (1992) developed a model to detect the incidence of predation in the bus industry. Third, some authors were aware of the importance of predation as a factor of market evolution in the bus industry. However, before deregulation most trusted that the competition authorities would be prepared to prevent such action (Foster and Golay, 1986). Given the striking number of competition cases in the bus industry it is amazing that the arguments for the motivation of predation in this industry have remained cursory.

Roberts (1982, hereafter MR) and Kreps and Wilson (1982, hereafter KW) showed how reputation effects can deter entry of small firms into distinct markets of a chain-store. Benoit (1983), Bolton and Scharfstein (1990) and others showed how large firms may use their financial clout to deter entry of small firms. These results were important since they provided formal underpinning to previous arguments that predation may be a rational strategy although it is costly in the short run.

Following work on reputation effects concentrated on varying the assumptions with regard to the informational structure and tested the robustness of results and investigated reputation effects in various settings.⁴ The more recent literature on the long-purse effect focussed on investigating the nature of the capital market imperfections that explain why some firms may be financially more constrained than others.⁵

Three reasons prevent us from simply applying these models to industries with localised competition. First, we find that the existing reputation models have two fundamental problems. They predict that singlemarket (sm) firms will enter one or more markets of the multimarket (mm) firm that are played “late” in the game. This prediction seems difficult to reconcile with a geographical interpretation of markets like in the chain-store game or in transport markets where the sequence of markets is not obvious and hence should not drive results. Moreover, and related, traditional reputation models force some entrant to be the first to make its entry decision without being able to reconsider it later. This assumption seems strong since in reality sm-firms may prefer to wait in order to observe others testing the type of the mm-firm. In our model sm-firms are able to reconsider their decision to stay out when they learn more about the type of the mm-firm. As a result we obtain a free-rider effect and more plausible predictions that strengthen the result of MR and KW.

Second, existing reputation and long purse models have shown why a monopolistic market structure may persist. However, we would like to learn more about market evolution, asking whether reputation and long purse effects can explain rational predatory entry of mm-firms in markets of sm-firms. In order to analyse this question we develop a reputation model with two source games and re-interpret the long purse model. We find that “large” mm-firms have an incentive for predatory entry and are able to specify what

⁴Fudenberg and Levine (1989) were able to derive the same basic intuition in a more general setting. They did not restrict the number of types, showed that a normal player would choose to imitate the most favourable type and showed that in any Nash equilibrium, provided that there are enough periods and the discount factor approaches one, the payoff of the normal “chain-store” cannot be much below the payoff of the mimicked store. Following work continued to investigate lower bounds in more general classes of repeated games (Schmidt 1993, Cripps and Thomas 1995, Celentani et al. 1996).

⁵This has been the focus of Bolton and Scharfstein (1990) as well as Hendel (1996).

“large” means in the context of both models.

Third, although there are a number of reputation models that investigate strategic interaction of two “long-lived” players, there is no analysis of two multimarket firms operating in different markets and considering entering a market of a mm-rival.⁶ We analyse strategic interaction of two multimarket firms and show that large firms collude in the sense that they avoid attacking each other.

Based on the results of our analysis we claim that predation theories provide a more consistent explanation of market evolution and fit the stylised facts much better than circular city models or the contestable markets approach used before. This leads to an important policy implication. When liberalising (network) industries with localised competition an effective enforcement of anti-predation rules is warranted. Unless this is ensured, there is an incentive to grow in order to reap the benefits of controlling many markets: behavioural barriers to entry, the opportunity for (a credible threat of) predatory entry, and, finally, collusion with other mm-firms. The limited success of competition authorities to prevent a process of concentration in some of these markets suggests that there is room for improvement in competition policy.

The paper is organised as follows. Section 2 sets up the basic reputation model. This model is used in section 3 in order to analyse equilibrium entry decisions in different entry constellations (singlemarket firms challenge a multimarket firm, a multimarket firm challenges a singlemarket firm, a multimarket firm challenges another multimarket firm). Section 4 introduces a different setup in order to analyse the impact of imperfect capital markets on the entry behaviour of multimarket firms. In section 5 we compare our results with the stylised facts sketched above. The conclusions are presented in section 6.

2 The reputation model

In this section we develop a reputation game which is based on the games introduced by MR and KW. Their work was inspired by Selten’s analysis of a complete and perfect information game in which a chain-store was unable to deter entry, although intuition suggested that it should be able to do so (Selten 1978). Following Selten’s suggestion to look for amendments to the strict backwards induction argument in order to resolve the paradox, MR and KW developed the notion of “reputation”. They showed that if there is some element of uncertainty regarding the type or the behaviour of the

⁶Schmidt (1993), Cripps and Thomas (1995) and Celentani et al. (1996) investigate strategic interaction of two long-run players.

incumbent, he may have an incentive to invest in gaining or maintaining a reputation for being tough in order to deter entry in other markets. As a result, if there is a minimum number of “other markets” (potential entrants), the incumbent’s strategy may include fighting in some markets although in the short run this implies losses.

2.1 The game with complete information

We consider a game with a multimarket (mm) firm b that is the incumbent operator in M identical markets and co-ordinates decisions of its subsidiaries in these markets. Each of these markets is subject to potential entry by a singlemarket (sm) firm. The entry games are played sequentially and each player can observe the actions of firms in those market games that have been played before. Markets are indexed backwards, i.e. the entry game in market M is played first. We denote the set of (identical) sm-firms by $S = \{a_1, \dots, a_M\}$, where sm-firms a_M, \dots, a_1 are the potential entrants, each for a different market.

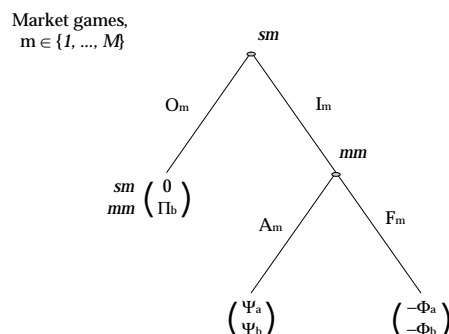


Figure 1: Market games (normal types)

The entry game has two stages (see Figure 1). In the first stage the sm-firm either enters market $m \in \{1, \dots, M\}$, denoted I_m , or stays out, O_m . In the latter case the market game ends, the sm-entrant gets a payoff of zero and the mm-incumbent earns monopoly profits, $\Pi_b > 0$. If the sm-firm enters, it is the mm-firm’s turn to either fight, F_m , or to acquiesce A_m . In case the mm-firm fights, both lose money, $-\Phi_i < 0$ (for $i = a, b$). If the mm-firm acquiesces, both earn strictly positive profits, Ψ_i (for $i = a, b$). For each firm the payoff of acquiescing is lower than monopoly profits. Taken

together these assumptions imply

$$-\Phi_i < 0 < \Psi_i < \Pi_i \quad \text{for } i = a, b.$$

The payoffs in the market games are designed in a way which suggests that if the market game is played with complete and perfect information, the sm-entrant will never choose O_m since the mm-firm will always acquiesce rather than fight in the last subgame. By backward induction, this result does not change if the market game is repeated finitely often, the so-called chain-store paradox.

2.2 The game with incomplete information

In one way or another all approaches, which intend to solve the paradox, introduce uncertainty in order to overcome the problem of backward induction leading to implausible equilibrium outcomes in complete and perfect information games with a finite horizon. We follow KW and assume that with a small initial probability the mm-firm is “tough” rather than normal. We denote the type $\theta_b = \{\theta_b^{tough}, \theta_b^{normal}\}$ and the (perceived) initial probability that the mm-firm is tough β , i.e. $prob(\theta_b = \theta_b^{tough}) = \beta$. These priors are common knowledge. At the beginning of a market game m the players’ belief that the mm-firm is tough is denoted by p_m . In order to simplify the analysis we deviate from KW by assuming that tough firms have a reduced action space compared to the normal types.⁷ Tough mm-firms can only respond to I_m by choosing F_m . We will solve for perfect Bayesian equilibria (PBE).

In the following we want to concentrate on cases where reputation effects may matter. In order to do so we need to eliminate two trivial cases.

2.3 Requirements for reputation to evolve

If the prior probability that the mm-firm is tough, β , is sufficiently high, an sm-firm will choose O_m even if markets are considered in isolation. In order to make the game interesting we think of the probability β as being low. That is we assume $0 < \beta(-\Phi_a) + (1 - \beta)\Psi_a$ or

$$\beta < \frac{\Psi_a}{\Psi_a + \Phi_a} \equiv \bar{\beta} \quad (1)$$

such that an sm-firm chooses I_m if only one market game is played.

Even if markets are informationally linked, firms may not want to invest in reputation. A necessary condition for mm-firms strictly preferring to fight

⁷In this respect we follow MR. KW do not restrict the action space but focus on “reasonable” equilibria - yielding the same outcome.

is that the profits of a successful entry deterrence are higher than the profits of acquiescing:

$$-\Phi_b + \Pi_b > 2\Psi_b \quad (2)$$

We will restrict our analysis to cases where equation (2) is satisfied so that reputation effects can arise if there are at least two markets that are informationally linked.

2.4 Standard results

In standard reputation models in the tradition of the chain-store paradox market games are played sequentially and sm-firms that have chosen to stay out cannot reconsider their decision even if they observe the mm-firm acquiescing in later markets. In this setup the following beliefs and strategies form a PBE.

The beliefs of sm-firms about the type of the mm-firm are updated on observed actions using Bayes rule where possible. In the first period set $p_M = \beta$. In all following periods:

$$p_m = \begin{cases} p_{m+1} & \text{if } O_{m+1} \\ 0 & \text{if } I_{m+1} \text{ and } A_{m+1}, \text{ or} \\ & \text{if } I_{m+1} \text{ and } F_{m+1} \text{ and } p_{m+1} = 0 \\ \max(\bar{\beta}^m, p_{m+1}) & \text{if } I_{m+1} \text{ and } F_{m+1} \text{ and } p_{m+1} \neq 0 \end{cases}$$

That is up to the first entry sm-firms cannot update their beliefs and they make use of the prior probability that the mm-firm is tough. If the mm-firm is observed acquiescing on entry, the sm-firms in following markets will set $p_m = 0$ since tough mm-firms cannot choose to acquiesce. If the mm-firm has acquiesced once, sm-firms will continue to believe that the mm-firm is normal ($p_m = 0$), even if they observe the mm-firm fighting in a market after it has acquiesced. This is because they *know* that the mm-firm is normal when it has acquiesced once. If the mm-firm has not yet acquiesced before and fights on entry of an sm-firm, the sm-firms will revise their belief that the mm-firm is tough upwards if $\bar{\beta}^m > p_{m+1}$. Note that the critical value $\bar{\beta}^m$ increases the fewer markets m are left to play.

The strategy of sm-firms is:

$$\begin{cases} O_m & \text{if } p_m > \bar{\beta}^m \\ I_m \text{ with probability } \gamma = \frac{\Pi_b - 2\Psi_b - \Phi_b}{\Pi_b - \Psi_b} \text{ and} & \\ O_m \text{ with the complementary probability} & \text{if } p_m = \bar{\beta}^m \\ I_m & \text{if } p_m < \bar{\beta}^m \end{cases}$$

The sm-firms' equilibrium actions depend on the relation $\bar{\beta}^m$ to p_m . If $p_m > \bar{\beta}^m$ they will stay out, if $p_m < \bar{\beta}^m$ they enter. If $p_m = \bar{\beta}^m$ they randomise. The entry probability γ is such that mm-firms may randomise between fighting and acquiescing in the preceding market.

The strategy of a (normal) mm-firm is:

$$\left\{ \begin{array}{ll} F_m & \text{if } m \geq 2 \text{ and } p_m \geq \bar{\beta}^{m-1} \\ F_m \text{ with probability } \sigma_m = \frac{p_m}{(1-p_m)} \left(\frac{1-\bar{\beta}^{m-1}}{\bar{\beta}^{m-1}} \right) \text{ and} & \\ A_m \text{ with the complementary probability} & \text{if } m \geq 2 \text{ and } p_m < \bar{\beta}^{m-1} \\ A_1 & \text{if } m = 1 \end{array} \right.$$

Note that a tough mm-firm can only fight. A normal mm-firm will imitate a tough mm-firm as long as $p_m \geq \bar{\beta}^{m-1}$. Once p_m is below that critical level it will randomise between fighting and acquiescing. The fighting probability σ_m ⁸ is such that the sm-firm in m may randomise its entry decision. Note that $\sigma_m = 0$ if $p_m = 0$. In the last market the normal mm-firm acquiesces since there are no gains from imitating the tough mm-firm.

Proposition 1 (*KW*⁹) *If $\beta \neq \bar{\beta}^m$ for any $m \leq M$, then the beliefs and strategies given above constitute the unique PBE.*

If $\beta = \bar{\beta}^m$ for any $m \leq M$, the PBE is not unique since the sm-firm a_m can choose I_m with any probability. This does not affect equilibrium strategies of the other firms.

Figure 2 shows an example of how the game can be played in equilibrium. In markets M to \tilde{m} the mm-firm fights with probability one and the sm-firms stay out. In the following market, $\tilde{m} - 1$, we have $p_m < \bar{\beta}^m$. Thus the sm-firm enters and the mm-firm randomises between fighting and acquiescing. In our example the mm-firm fights. The sm-firm in market $\tilde{m} - 2$ updates its beliefs and randomises on entry, the mm-firm randomises between fighting and acquiescing. In the example the sm-firm enters and the mm-firm acquiesces. From then until the end of the game equilibrium play in each market m will be I_m and A_m .

⁸Note that $0 < \sigma_m < 1$. This follows from $p_m < \bar{\beta}^{m-1}$.

⁹KW use the concept of sequential equilibrium. Since the game has only two types PBE gives the same results (see Fudenberg and Tirole 1990). KW do not restrict action spaces of tough types. After eliminating unreasonable out-of-equilibrium beliefs they obtain unique on-the-equilibrium-path strategies in the parameter space $\beta \neq \bar{\beta}^m$. Our stronger result stems from the fact that if the mm-firm acquiesced once, the sm-firms cannot - even off the equilibrium path - revise their belief that the mm-firm is normal.

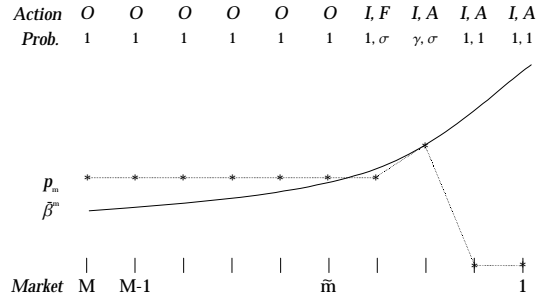


Figure 2: An example for actual play in equilibrium

2.5 A new timing of the game

In this section we amend the timing of the standard reputation model for two reasons. The prediction of traditional reputation games that one or more “late” markets will be challenged by an entrant whereas in “early” markets entry is deterred seems difficult to interpret in the context of a geographical interpretation of markets like in the chain-store game or in transport industries. The outcome of a market game should (at least in equilibrium) not depend on where it is positioned in the sequence.¹⁰

Moreover, traditional reputation models make the strong assumption that an sm-firm can be forced to be the first to make its entry decision without being able to reconsider it. We believe that a multimarket reputation model should capture the following intuition. If nobody forces an sm-firm to enter as the first sm-firm, it may well be that nobody wants to test the water and all stay out. We suggest a different timing of the model that takes this free rider effect into account and yields more plausible predictions.

The main innovation is that sm-firms may reconsider their entry decision when they observe that the mm-firm acquiesced: Suppose all M markets are played once according to the sequence and rules defined above. After this

¹⁰A related point has been made by Masso who argued that it is a shortcoming of the traditional reputation games to assume that “...agents can distinguish between those firms that have not yet decided whether to enter the market or not and those that have *already* decided *not* to enter” (Masso 1996, p. 58). Contrary to our approach he assumes uncertainty about the ordering and imperfect information on the history of the game. In the original chain store game (second version) Selten avoided this problem by assuming that before a market game is played all potential entrants decide whether to enter or not. Then a random mechanism selects one player that is allowed to enter (Selten 1978, p. 134).

first round, one out of three situations may prevail. Either the set of sm-firms that chose O during the first round is empty so that all sm-firms entered or all have decided to stay out. In these two cases the game ends after all markets have been played once. If, however, some but not all sm-firms have decided to stay out, these firms can play again in a second round.

More generally, let $S_r \subseteq S$ be the set of sm-firms that chose O in all rounds preceding round r and let $S_{r+1} \subseteq S_r$ be the set of sm-firms that chose O in round r and all preceding rounds. In other words S_r denotes the set of potential entrants in round r . The game is played over a sequence of rounds $r = 1, \dots, R$, where R is determined by the players' strategies. If after round r we have $S_{r+1} \neq S_r$ and $S_{r+1} \neq \emptyset$, sm-firms S_{r+1} play another round, $r + 1$. In the first round r , after which $S_{r+1} = S_r$ or $S_{r+1} = \emptyset$, the game ends and we denote that round by R . In any round $r \leq R$ we will call the market with the lowest index the “last” market so that if in this round all sm-firms with a higher index choose O , the last sm-entrant decides whether the game will be continued or not.¹¹ Let m denote the number of sm-firms that have not yet entered at any given history. Note that at the beginning of each round we have $m = |S_r|$. Moreover, it is convenient to denote the belief of the sm-firms that the mm-firm is tough at any period in which m sm-firms have not yet entered by p_m .¹²

3 Equilibrium entry decisions

We begin our analysis by identifying the general conditions under which sm-firms other than the last in a round will prefer to choose O in order to “wait and see”. In a next step we show that these conditions almost always hold in the context of our multimarket game.

3.1 The externality effect

In equilibrium it will be the last firm in a round that decides whether a game is continued (if it chooses I) or whether it ends (if it chooses O). Two lemmas lead to this result.

Lemma 1 *If in any round \hat{r} the mm-firm acquiesces or if in that round $p_m = 0$, then all firms in $S_{\hat{r}}$ enter with probability one before the game terminates and the mm-firm responds with acquiescence to every entry.*

¹¹In case the game was played as a complete information game with only normal types, we would obtain the chain store paradox: all sm-firms would choose to enter and the mm-firm would acquiesce in every market.

¹²Note that sm-firms always share the same belief about the type of the mm-firm. This is required by our solution concept, PBE.

Proof. To prove the lemma it suffices to show that in every round $r \geq \hat{r}$ at least one sm-firm in S_r will choose I until $S_r = \phi$. Note that if $m = 1$ and the sm-firm in S_r chooses I , a normal mm-firm acquiesces, independent of the history of play up to this round. This follows immediately from the payoff structure ($\Psi_b > -\Phi_b$) and the fact that the game ends after this move of the mm-firm. Now suppose $m = 2$ and the firms in S_r know that the mm-firm is normal since it has acquiesced in a previous round, $p_m = 0$.¹³ Suppose the first firm has chosen O and consider the decision problem of the last sm-firm. Since in the next and final round the sm-firm which chose O in the current round will choose I , independent of the mm-firm's play in the current round, the mm-firm will acquiesce with probability one ($2\Psi_b > -\Phi_b + \Psi_b$). Hence the last firm in S_r with $m = 2$ will choose I . Thus at least one firm enters when $m = 2$. By backward induction this applies to all rounds that follow a round r in which the mm-firm acquiesced such that in these rounds we have $p_m = 0$. ■

This result is not surprising since after the occurrence of acquiescence uncertainty vanishes and we find the full information result of the original chain-store game of Selten (1978).

Lemma 2 *Suppose the sm-firms in round r believe that the response to the first entry in this round will be a fight with probability $f > 0$ and, in case the last sm-firm is indifferent, it chooses I with positive probability. Then any sm-firm in S_r that is not the last sm-firm in round r will always choose O .*

Proof. Consider a game in round r in which $m \geq 2$ and $p_m > 0$.¹⁴ Let f be the probability with which the sm-firms believe that the mm-firm will fight.

If $0 > f(-\Phi_a) + (1 - f)\Psi_a \Leftrightarrow f > \bar{\beta}$ an sm-firm will choose O since the probability f that the mm-firm will respond to I with a fight is large in the sense that I would yield the sm-firm an expected value smaller than zero.

If $f < \bar{\beta}$ and all sm-firms except the last choose O (no updating) the last firm will choose I with probability one, since the expected payoff of entering is greater than zero. Choosing O is optimal for all sm-firms in S_r except the last since the expected payoff of choosing I in round r , $f(-\Phi_a) + (1 - f)\Psi_a$, is smaller than the expected payoff of choosing O , which is bounded from below by $(1 - f)\Psi_a$. This lower bound on the expected payoff of choosing O follows from Lemma 1 and the fact that the last sm-firm will enter with

¹³Note that $p_m = 0$ after any incidence of acquiescence, even if the mm-firm - out of equilibrium - chooses to fight in one or more later periods. Given that we restricted the action space of the tough mm-firm to fighting, the sm-firms must believe that the mm-firm is normal once they have observed it acquiescing once.

¹⁴Due to symmetry of the sm-firms, common knowledge of priors and full observability of the history of moves, all sm-firms share the same beliefs about the type of the mm-firm in any given period.

probability one. By entering, the last firm bears the risk of being fought in this round. Since each of the other sm-firms can choose to enter in the next round if and only if there was no fight in this round, and with probability $(1 - f)$ there is no fight in this round, their profits are bounded from below by $(1 - f) \Psi_a$ by Lemma 1.

Thus, for $f \neq \bar{\beta}$ and a positive probability of a fight ($f > 0$) all sm-firms in S_r except the last will choose O in equilibrium.

If $f = \bar{\beta}$ an sm-firm is indifferent between I and O unless choosing O leads to a continuation game with an expected value greater than zero. In this case we require the assumption that the last firm will choose I with positive probability in case it is indifferent. Suppose the sm-firm with the highest index in round r chooses O . In this case the sm-firm in the following market cannot update beliefs about the mm-firm so that the probability of a fight is still f . Suppose this and all the following sm-firms except the last choose O . Then the last sm-firm will be indifferent between I and O . Let it choose I with positive probability γ . Then with probability $\gamma(1 - f)$ both the sm-firms observe that the mm-firm acquiesces in the last market. In this case, by Lemma 1, all remaining sm-firms in S_r choose I and the mm-firm acquiesces. Thus the sm-firm's expected payoff of choosing O is at least $\gamma(1 - f)\Psi_a > 0$. Thus all sm-firms with a higher index in S_r have moved optimally by choosing O . ■

3.2 Singlemarket firms challenge a multimarket firm

In this section we analyse equilibrium strategies and beliefs, given the new timing of the game. In order to characterise results we make use of the following terminology: We say that a normal mm-firm has a “*detering fighting incentive*” in market m when the sm-firm chooses O_m with probability one, because it fears that the mm-firm will fight with high enough probability. The normal mm-firm is said to have a “*strong fighting incentive*” if it strictly prefers fighting. Note that every strong fighting incentive is also detering but not vice versa.

Proposition 2 *If $\beta > \bar{\beta}^M$, the sm-entry game has a unique PBE outcome¹⁵ in which a normal mm-firm has a detering fighting incentive in market M . Given this incentive, all sm-firms will be deterred.*

Proposition 2 strengthens the result of the usual reputation models of the chain-store game. It implies that no sm-firm enters in equilibrium if the

¹⁵Note that the behaviour on the equilibrium path is unique too. However, the equilibrium behaviour is supported by non unique behaviour off the equilibrium path (lemma 1 does not state in which round sm-firms enter).

mm-firm has a deterring fighting incentive, whereas in the models of KW and MR sm-firms enter with positive probability when they are playing late in the game. Despite this difference in equilibrium outcome, we obtain almost the same equilibrium strategies and beliefs. Before proving Proposition 2 we discuss those in more general terms.

We first focus on the response of a normal mm-firm to the first entry in a given round and show that the probability of fighting does not depend on the position of a firm within a given round. This implies that the first condition of Lemma 2 holds in equilibrium.

If in any round r we have $m = 1$, the normal mm-firm will acquiesce since it cannot gain from building a reputation. The sm-firm's decision depends on its belief that the mm-firm is tough, given previous play: if $p_1 < \bar{\beta}$ it will choose I_1 , if $p_1 > \bar{\beta}$ it will choose O_1 , and if $p_1 = \bar{\beta}$ the sm-firm is indifferent between I_1 and O_1 .

Consider a game in round r in which $m = 2$ and the belief of the sm-firms in S_r that the mm-firm is tough is $p_2 < \bar{\beta}$. The first entry may occur either in the first or in the last market of this round. Fix any of the two markets as the one where the first entry occurs and label it "market 2" (and label the other "market 1").

In equilibrium the normal mm-firm in market 2 will neither fight nor acquiesce with probability one. If it fought with probability one, the sm-firm in market 1 could not update its belief and would enter. Then fighting in market 2 cannot be optimal since it has no deterrence effect. If the strategy of the normal mm-firm was to acquiesce with probability one, the sm-firm in market 1 would infer from a fight in market 2 that the mm-firm is tough and would choose O_1 . Then A_2 cannot be optimal. In equilibrium the mm-firm fights with probability $\sigma_2 = \frac{p_2}{1-p_2} \left(\frac{1-\bar{\beta}}{\bar{\beta}} \right)$ so that if it does fight $p_1 = \bar{\beta}$ by Bayes rule¹⁶. Then, if a fight occurs in market 2, the sm-firm in market 1 is indifferent and randomises on entry such that the mm-firm is indifferent between fighting or acquiescing in market 2. Thus fighting with probability σ_2 is the unique equilibrium strategy of the mm-firm in this situation.

Now consider a game in round r in which $m = 3$ and the belief of the sm-firms in S_r that the mm-firm is tough is $p_3 > \bar{\beta}^2$. Again fix any of the three markets as the one where the first entry occurs and label it "market 3" (and label the others arbitrarily "1" and "2", where "2" is the market that is played next). If the mm-firm fights with probability one in market 3 there will be no updating. However, since $p_2 > \bar{\beta}^2$ is sufficient to deter entry in the following market, fighting in market 3 is now the optimal strategy.

¹⁶By Bayes rule we have $p_1 = \frac{1 \cdot p_2}{p_2 + \sigma_2(1-p_2)}$. Setting p_1 equal to the critical level $\bar{\beta}$ and solving for σ_2 yields $\sigma_2 = \frac{p_2}{1-p_2} \left(\frac{1-\bar{\beta}}{\bar{\beta}} \right)$.

If $p_3 \leq \bar{\beta}^2$ the normal mm-firm will neither fight nor acquiesce with probability by the same reasoning as in round r in which $m = 2$. Rather fighting with probability $\sigma_3 = \frac{p_3}{1-p_3} \left(\frac{1-\bar{\beta}^2}{\bar{\beta}^2} \right)$ is the unique equilibrium strategy. The normal mm-firm can now plan to fight with a higher probability than in 2 (i.e. $\sigma_3 > \sigma_2$) since p_2 required to make the sm-firm in 2 indifferent is $\bar{\beta}^2 < \bar{\beta}$.

Working backwards this way we obtain the equilibrium response to entry of a normal mm-firm (tough mm-firms can only fight):

$$\left\{ \begin{array}{ll} F_m & \text{if } m \geq 2 \text{ and } p_m \geq \bar{\beta}^{m-1} \\ F_m \text{ with probability } \sigma_m = \frac{p_m}{(1-p_m)} \left(\frac{1-\bar{\beta}^{m-1}}{\bar{\beta}^{m-1}} \right) \text{ and} & \\ A_m \text{ with the complementary probability} & \text{if } m \geq 2 \text{ and } p_m < \bar{\beta}^{m-1} \\ A_1 & \text{if } m = 1. \end{array} \right. \quad (3)$$

Note that the strategy of the mm-firm depends only on the post-entry number of potential future entrants m and the current belief that the mm-firm is tough, p_m . Thus the strategy is independent of the address of the sm-firm that chooses to enter first in a given round.

While analysing the strategy of the normal mm-firm we have taken the belief of the sm-firms in the first market where entry occurs as given by p_m . This belief must, of course, evolve from the beginning of the game. However, since sm-firms cannot update their belief if no entry occurs, the belief p_s in any period s is fully defined by the belief p_m in any period in which m firms that have not yet entered. In the first period set $p_m = p_M = \beta$. In all following periods the beliefs are:

$$p_m = \begin{cases} 0 & \text{if } I_{m+1} \text{ and } A_{m+1}, \text{ or} \\ & \text{if } I_{m+1} \text{ and } F_{m+1} \text{ and } p_{m+1} = 0 \\ \max(\bar{\beta}^m, p_{m+1}) & \text{if } I_{m+1} \text{ and } F_{m+1} \text{ and } p_{m+1} \neq 0. \end{cases} \quad (4)$$

If the mm-firm has not yet acquiesced in any market and it is observed fighting, the sm-firms revise their belief that the mm-firm is tough upwards if $\bar{\beta}^m > p_{m+1}$. The beliefs are Bayesian consistent with the strategy of the normal mm-firm except for F_{m+1} if $p_{m+1} = 0$ and for A_{m+1} if $p_{m+1} \geq \bar{\beta}^m$. In both cases we set $p_m = 0$ since sm-firms *know* that the mm-firm is normal when it has acquiesced once. Thus they will continue to believe that the mm-firm is normal ($p_m = 0$), even if they observe the mm-firm fighting in a market after it has acquiesced.

Given the strategy of the mm-firm and the beliefs we can now turn to the strategy of the sm-firms. By Lemma 2 any sm-firm in S_r that is not the last sm-firm in round r will always choose O . The Lemma requires, first, that the last firm enters with positive probability if all other firms choose to

stay out and, second, that the probability, f , with which the sm-firms in a given round believe that the mm-firm will fight is equal across all sm-firms and does not change until the response to the first entry can be observed.

The latter condition is satisfied if δ , the probability that a normal mm-firm fights, does not depend on the position of a sm-firm in a given round. It suffices to analyse δ since $f = p_m + (1 - p_m)\delta$ and p_m is equal across all sm-firms and cannot be updated until the first entry occurs. However, we have already shown that the fighting probability δ does not depend on the position of the market where the first entry occurs in a given round.

Note that it is important for this result that the belief p_m is a sufficient statistic for the history of the game up to any period. Since updating is not possible if sm-firms choose to stay out p_m is equal across all sm-firms up to the first entry. Moreover, since we allow sm-firms that have decided to stay out in a given round to play again if entry occurs in that round the post-entry continuation game (the number of markets in which entry can potentially be deterred) is independent from where in a given round entry occurs. Thus in each round, δ is equal across markets until the first entry occurs and the first condition of Lemma 2 is satisfied.

The first condition requires that the last sm-firm enters with positive probability if all other sm-firms choose to stay out. Suppose in a given round all sm-firms other than the last choose to stay out. Any last sm-firm in a given round behaves completely myopic and the optimal entry behaviour follows directly from the equilibrium strategy of the mm-firm and the associated beliefs. With $f = p_m + (1 - p_m)\delta$ and $\sigma_m = \frac{p_m}{(1-p_m)} \left(\frac{1-\bar{\beta}^{m-1}}{\bar{\beta}^{m-1}} \right)$ by the strategy of the normal mm-firm we have $f \geq \bar{\beta} \Leftrightarrow p_m \geq \bar{\beta}^m$. Thus if $p_m > \bar{\beta}^m$ we have $f > \bar{\beta}$ and by equation (1) the expected payoff of entering, $f(-\Phi_a) + (1 - f)\Psi_a$, is smaller than zero and the sm-firm chooses O_m . If $p_m < \bar{\beta}^m$ we have $f < \bar{\beta}$ the expected payoff is strictly positive and it chooses I_m . In case $p_m = \bar{\beta}^m$ the sm-firm is indifferent between I_m and O_m ($f = \bar{\beta}$). In this case the sm-firm will randomise and choose I_m with probability γ_m , which supports the randomising strategy of the mm-firm in market $m + 1$ by equalising the returns of fighting and acquiescing in $m + 1$. The expected payoff to fighting now is $-\Phi_b + (1 - \gamma_m)m\Pi_b + \gamma_m m\Psi_b$, i.e. γ_m is chosen so that

$$-\Phi_b + (1 - \gamma_m)m\Pi_b + \gamma_m m\Psi_b = (m + 1)\Psi_b$$

yielding $\gamma_m = \frac{m\Pi_b - (m+1)\Psi_b - \Phi_b}{m(\Pi_b - \Psi_b)}$.¹⁷ Thus in any round we have the following strategy for the last sm-firm provided that all other sm-firms have chosen to

¹⁷It follows from assumption (2) that $0 < \gamma_m < 1$. Note that γ_m differs from the entry probability in the standard reputation games, $\gamma = \frac{2\Psi_b - \Pi_b + \Phi_b}{\Psi_b - \Pi_b}$, since given the new timing O_m leads to monopoly profits in all m markets.

stay out:

$$\left\{ \begin{array}{ll} O_m & \text{if } p_m > \bar{\beta}^m \\ I_m \text{ with probability } \gamma = \frac{m\Pi_b - (m+1)\Psi_b - \Phi_b}{m(\Pi_b - \Psi_b)} \text{ and} & \\ O_m \text{ with the complementary probability} & \text{if } p_m = \bar{\beta}^m \\ I_m & \text{if } p_m < \bar{\beta}^m. \end{array} \right. \quad (5)$$

If $p_M \neq \bar{\beta}^M$, last sm-firms that randomise enter with probability $\gamma_m > 0$ which satisfies the second condition and Lemma 2 applies. In this case all sm-firms but the last will indeed stay out. Only in the knife edge case where $p_M = \bar{\beta}^M$ the last sm-firm in the first round is indifferent and it may enter with any probability, including zero. As a result any sm-firm moving earlier may or may not enter (i.e. Lemma 2 does not apply). In this case we do not obtain uniqueness as in the traditional model by KW.

In equilibrium the expected payoff of a normal mm-firm in a period with m potential entrants $v_m(p_m)$ is as follows:

- (i) If $p_m < \bar{\beta}^m$, the expected payoff is $v_m(p_m) = m\Psi_b$.
- (ii) If $p_m = \bar{\beta}^m$, the expected payoff is $v_m(p_m) = (1 - \gamma_m)m\Pi_b + \gamma_m m\Psi_b > m\Psi_b$, where $\gamma_m = \frac{m\Pi_b - (m+1)\Psi_b - \Phi_b}{m(\Pi_b - \Psi_b)}$.
- (iii) If $p_m > \bar{\beta}^m$, the mm-firm has a deterring fighting incentive and the expected payoff is $v_m(p_m) = m\Pi_b$.

For the sake of completeness we check in general the optimality of the equilibrium strategy of the normal mm-firm. The move F_m if $m \geq 2$ and $p_m \geq \bar{\beta}^{m-1}$ is optimal since $-\Phi_b + (m-1)\Pi_b > m\Psi_b$. The move F_m with probability $\sigma_m = \frac{p_m}{(1-p_m)} \left(\frac{1-\bar{\beta}^{m-1}}{\bar{\beta}^{m-1}} \right)$ if $m \geq 2$ and $p_m < \bar{\beta}^{m-1}$ is optimal since $-\Phi_b + (1 - \gamma_{m-1})(m-1)\Pi_b + \gamma_{m-1}(m-1)\Psi_b = m\Psi_b$.

Given the equilibrium strategies and beliefs, the proof of Proposition 2 is straight forward:

Proof. Suppose $\beta > \bar{\beta}^M$. Since $\beta \neq \bar{\beta}^M$ Lemma 2 applies and all sm-firms up to the last choose O . Then $p_m = \beta > \bar{\beta}^m = \bar{\beta}^M$ and by the equilibrium strategy (5) the last sm-firm chooses O_m . Thus all sm-firms choose O . Hence, by definition, the mm-firm has a deterring fighting incentive and remains monopolist in all M markets. ■

3.3 A multimarket firm challenges a singlemarket firm

In this section we allow the mm-firm to enter the market M of an sm-firm. It turns out that mm-firms that are “large” not only benefit from deterring

entry of sm-firms but have an incentive to expand via predatory entry into markets of sm-firms.

The mm-firm is the incumbent operator in $M - 1$ markets. As in the sm-entry game each of these markets is subject to potential entry by a sm-firm. In addition, we consider a market, M , in which a sm-firm is the incumbent operator and the mm-firm the potential entrant. Due to this characteristic we refer to our game as an “mm-entry game” as opposed to the “sm-entry game” of the previous section which is restricted to analyse entry decisions of sm-firms.

We denote the set of sm-firms by $S = \{a_1, \dots, a_M\}$. The sm-firms in S are all identical, with the exception that a_M is an incumbent and the remaining sm-firms are potential entrants (see Figure 3).

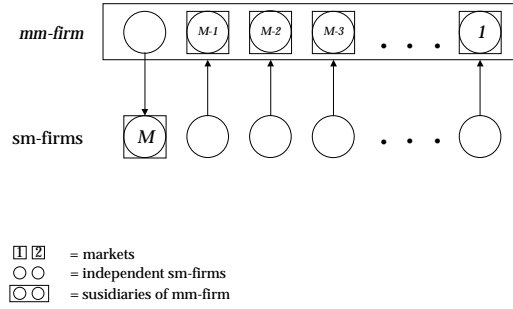


Figure 3: The mm-entry game, first round

The first entry game, played in market M , has three stages. In the first stage the mm-firm chooses to enter or to stay out. If the mm-firm chooses to stay out, this market game ends and the mm-firm receives zero payoff while the sm-incumbent earns monopoly profits, $\Pi_a > 0$. In case the mm-firm enters, the sm-firm can either stay in market M , I_M , or exit the market, O_M . In the latter case the market game ends and the sm-incumbent gets a payoff of zero and the mm-entrant earns monopoly profits, $\Pi_b > 0$. In the former case it is once again the mm-firm’s turn to either choose to fight, F_M , or to acquiesce A_M . The payoffs are defined as in the sm-entry game, i.e.:

$$-\Phi_i < 0 < \Psi_i < \Pi_i \quad \text{for } i = a, b.$$

In the following $M - 1$ markets the mm-firm operates as the incumbent. The game tree and the payoff-structure in these market games are exactly the same as in the post-entry subgame of the first market (see Figure 4). The

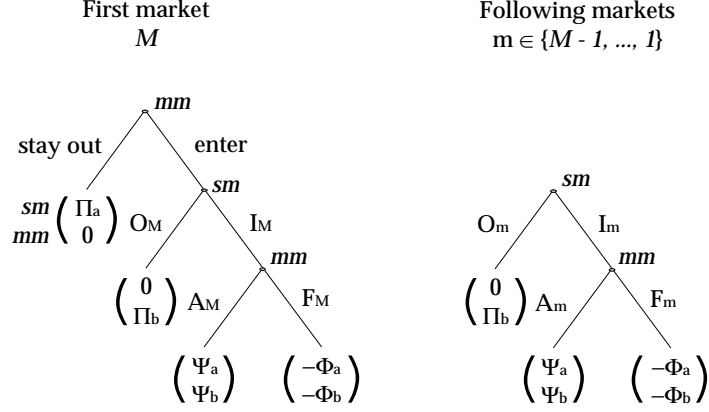


Figure 4: Market games (normal types)

only difference is that the sm-firms' actions need to be interpreted as enter I_m or stay out O_m for each market $m < M$.

Again there two types of mm-firms. As before, tough mm-firms can only respond to I_m by choosing F_m . Note that we do not restrict the action space of tough firms with regard to entering the market of the incumbent sm-firm in market M . Both tough and normal mm-firms have the choice to enter or to stay out.¹⁸

Proposition 3 *If $\beta > \bar{\beta}^M$, the mm-entry game has a PBE in which a normal mm-firm has a deterring fighting incentive in market M . Given this incentive, tough and normal mm-firms will enter with probability one, thereby induce exit of the sm-firm in M , and deter entry of all remaining $M - 1$ sm-entrants.*

Thus, for a given β , the normal sm-incumbent will exit if the mm-firm already operates in at least \tilde{m} markets, where \tilde{m} is the smallest integer so that $\beta > \bar{\beta}^{\tilde{m}+1}$.

Proof. Suppose the mm-firm has decided to enter market M . Denote the post entry belief of the sm-firm in M that the mm-firm is tough by p_M and

¹⁸This assumption is natural since we want to derive the entry behaviour of the both firms. In the context of the mm-entry game with sm-firms we would obtain the same results by assuming that tough mm-firms always enter. In section 3.4 we allow for more than one mm-firm and would obtain less plausible results if we assumed that tough mm-firms always enter.

assume that entry did not lead to an updating of beliefs, $\beta = p_M > \bar{\beta}^M$. In this case all sm-firms up to sm-firm in market 1 will choose O by Lemma 2. Thus the belief of the sm-firm in market one is still $\beta = p_M > \bar{\beta}^M$ and it will choose O_1 . Since the sm-firm in market one was the last firm, the game ends and the mm-firm's payoff is $M\Pi_b$. Thus tough mm-firms strictly benefit from entering, independent of the strategy of the normal mm-firm. To see this, suppose the normal mm-firm stays out. Then entering reveals that the mm-firm is tough and all sm-firms choose O . Suppose the normal mm-firm plans to enter too. Then there is no updating on entry, $\beta = p_M > \bar{\beta}^M$, and again all sm-firms choose O . Given that the tough mm-firm will enter market M with probability one, the normal mm-firm strictly benefits from imitating the tough mm-firm and both earn the maximum payoff of Π_b . ■

This PBE outcome is not unique. Suppose both tough and normal mm-firms plan to stay out of market M such that staying out does not lead to an updating of beliefs. If $\beta = p_{M-1} > \bar{\beta}^{M-1}$ all sm-entrants stay out and the mm-firm's payoff is $(M-1)\Pi_b$. This is an equilibrium strategy if small firms believe that the mm-firm is normal (with a high probability) when observing out-of-equilibrium entry of the mm-firm.

Although it is not very intuitive, this equilibrium survives standard equilibrium refinement concepts. This stems from the fact that for any out-of-equilibrium belief p_M both types of the mm-firm have exactly the same preferences with regard to defection. Thus on observing the defection one cannot learn anything about the type that would allow us to eliminate a type or restrict the posterior probability of a type.

Equilibrium domination refinements as well as D1 and D2 require that there is an asymmetric defection behaviour of types depending on the out-of-equilibrium beliefs (and responses) of the other players (Cho and Kreps 1987). Based on this asymmetry either type-message pairs are eliminated or the posterior probability of a type contingent on a message is restricted. Taking these refinements one step further one may argue that due to the symmetry in the defection incentives across types sm-firms should not update beliefs at all. This would eliminate the implausible equilibrium in our game.

We propose a different reasoning that seems more convincing in the context of our game. In the “non-entry equilibrium” we require sm-firms to raise the posterior probability that the mm-firm is normal when observing entry. However entering is the equilibrium strategy of both types in the “entry equilibrium” and this equilibrium yields a higher payoff for both types of the mm-firm¹⁹. Thus, we suggest that sm-firms will believe that entry has

¹⁹This also applies to mixed strategies: Any mixed entry strategy has, by definition, an mm-firm staying out of market M with positive probability, ω . Thus the expected payoff compared to the optimal $M\Pi_b$ is reduced by at least $\omega\Pi_b$.

been chosen as part of this equilibrium strategy rather than as a “mistake” in the context of the “non-entry equilibrium”. If so sm-firms cannot update their beliefs when they observe entry and the “non-entry equilibrium” is ruled out.²⁰

Propositions 2 and 3 have an interesting implication: If an mm-firm that operates in M markets has a deterring fighting incentive in market M , both the mm-entry game and the sm-entry game have all M sm-firms choosing O . This implication follows from the fact that both tough and normal mm-firms enter with probability one so that actions taken with positive probability and beliefs at the nodes, at which these actions are taken, are exactly identical in an mm-entry and an sm-entry game once in the mm-entry game the mm-firm has entered the first market.

3.4 A multimarket firm challenges another multimarket firm

We now investigate the fighting incentive if one multimarket firm considers entering a market of another multimarket firm. The standard approach in the reputation literature has two “long-lived” firms strategically interacting in a sequence of periods. It has been shown that reputation effects can be derived as long as the game is of conflicting interest (as the chain-store paradox, see Schmidt 1993). For two reasons the analysis of the strategic interaction of two long-lived players is more complicated than the analysis of one long lived firm facing several short lived rivals.²¹ First, long-run opponents need not play a short-run best response to the anticipated play of their opponents. Other strategies, including rewards and punishments, may lead to higher payoffs. Second, these rewards and punishments may have to be carried out occasionally in order to demonstrate their adoption.²² Based

²⁰Pitchik (1993) proposes a selection scheme for a chain-store game with reputation effects which ranks equilibrium outcomes in terms of the mm-firm’s payoff. This procedure also picks the plausible equilibrium in our game without referring to out-of-equilibrium beliefs.

²¹See for example Celentani et al. (1996), Cripps and Thomas (1995) as well as Evans and Thomas (1997).

²²This does not apply to the traditional chain store game. Schmidt (1993) has shown that in a game of two long-run players, player one will still be able to achieve his commitment payoff as long as the game is of conflicting interest (like the chain-store paradox) and player one is sufficiently more patient than player two. The basic intuition is that player two will not test player one’s type arbitrarily often since the returns from such an investment will not be valued accordingly if they occur too far in the future. The game needs to be of conflicting interest, i.e. the strategy to which player one would most like to commit himself holds player two down to his minimax payoff. Otherwise, one could construct a continuation equilibrium in which player two is punished if he plays his short-run best response against the commitment strategy, preventing him from doing so. As a result the

on our geographical interpretation of the “periods” another game structure seems more natural and allows a simpler analysis of the interaction of two multimarket firms. We assume that both mm-firms operate in a number of distinct markets and investigate the incentive of one mm-firm to enter a market of another mm-firm, knowing that the opponent operates in a number of other markets which can be challenged by sm-firms as potential entrants (see Figure 5).

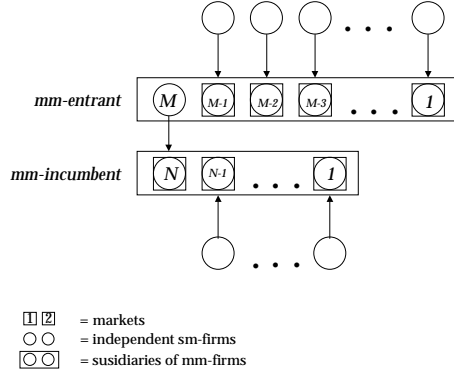


Figure 5: The mm-entry game with two mm-firms

Note that we now have two-sided uncertainty in market M since the mm-incumbent and the mm-entrant may be tough. The normal mm-incumbent in market M has the choice either to exit O or to stay I . We assume that the tough mm-incumbent has a restricted action space and can only choose I . This assumption is natural since it is closest to the idea that tough mm-firms will always fight. In order to make the game interesting we assume that the mm-entrant has a deterring fighting incentive in the first market. From Proposition 3 we know that in an mm-entry game with M markets the normal mm-entrant has a deterring fighting incentive in the plausible PBE, if $\beta > \bar{\beta}^M$ and a strong (and deterring) fighting incentive if $\beta > \bar{\beta}^{M-1}$. Note that this fighting incentive of the mm-entrant is independent of the expected behaviour of the mm-incumbent in the first market since it results from the intention to deter entry of the sm-firms in the other markets where the mm-entrant has the incumbent position.

Proposition 4 *If $\beta_b > \bar{\beta}_b^{M-1}$ and $\beta_a > \bar{\beta}_a^{N-1}$, an mm-entrant will not enter the market of an mm-incumbent in a PBE of the generalised mm-entry game.*

payoff is smaller than the commitment payoff. Such an equilibrium cannot be constructed if player two's payoff is restricted to his minimax payoff anyway and as a result there is no risk in playing a best response against the commitment strategy.

Proposition 4 implies that large firms do not hit each other. The proof is in three steps. We first show that the incumbent mm-firm will always choose I . In order to maintain the reputation of being tough the normal mm-entrant has to fight and the tough mm-entrant fights by definition. Both tough and normal firms prefer not to enter.

Proof. Suppose the mm-entrant enters market M , then the mm-incumbent will choose I , independent of his type. Tough mm-incumbents always choose I . The normal mm-incumbent has a strong fighting incentive, $\beta_a > \bar{\beta}_a^{N-1}$, and it will choose I with probability one, independent of the mm-entrant's strategy (or type). Even if the mm-entrant fights with probability one the mm-incumbent expects to earn more by choosing I than choosing O and revealing that it is normal. By Assumption (1) we have

$$-\Phi_a + (N - 1) \Pi_a > (N - 1) \Psi_a.$$

Given that the incumbent mm-firm will choose I with probability one, entering market M will cost the mm-entrant $-\Phi_b$, independent of his type, if he wants to maintain his reputation of potentially being tough. Thus tough mm-entrants will not enter market M . Since $\beta_b > \bar{\beta}_b^{M-1}$, the expected payoff of the ensuing sm-entry game is $(M - 1) \Pi_b$ independent of the strategy of a normal mm-entrant so that the expected payoff of entering market M is smaller:

$$-\Phi_b + (M - 1) \Pi_b < (M - 1) \Pi_b.$$

Since tough mm-entrants stay out of market M , doing the same does not reveal the type of a normal mm-entrant. Thus normal mm-entrants can avoid incurring the cost of fighting and still deter entry in the remaining $M - 1$ markets. In equilibrium both tough and normal firms with a strong fighting incentive will not enter a market in which they can expect the incumbent to stay in with probability one. ■

Again both types of the mm-firm cannot improve on this PBE. Any other equilibrium strategy has an mm-firm entering market M with positive probability, ω . Since the mm-incumbent will stay in with probability one, entering market M must lead to an expected payoff that is lower compared to $(M - 1) \Pi_b$. Either the mm-firm fights and (in the best case) maintains its reputation yielding $-\Phi_b + (M - 1) \Pi_b < (M - 1) \Pi_b$ or the mm-firm acquiesces yielding $M \Psi_b < (M - 1) \Pi_b$ (by Assumption 2).

Thus, by the same argument as for Proposition 3, we argue that sm-firms will not believe that either tough or normal mm-firms will choose to stay out by mistake (which is required to sustain any other PBE). Rather they will interpret this as an equilibrium move of the equilibrium proposed above.

Proposition 4 does not depend on the difference in size as such. Rather if the mm-incumbent controls a critical minimum of markets so that it has a

strong deterring fighting incentive it deters entry of firms that have a strong fighting incentive, even if they are much larger mm-firms.

The results for the remaining parameter constellations are provided in the appendix.

4 Multimarket firms and imperfect capital markets

The position of multimarket firms may be strengthened further if imperfect capital markets hinder perfect external funding of operations so that mm-firms have access to larger funds than sm-firms or smaller mm-firms. The idea that asymmetric financial constraints may provide a rationale for predatory behaviour has been thoroughly investigated by Benoit (1983). He counters the common argument that predation would be too costly to be a credible threat (or to occur) by showing that if strategic interaction with financial constraints is analysed in a repeated game with complete and perfect information predation may well play an important role in deterring entry even if the expected value of future monopoly profits would justify only one period of fighting and the financially constrained firm could survive a large number of periods.

In contrast to most recent work²³ on the long purse argument we do not intend to investigate more fully the nature of the capital market imperfections that give rise to these constraints - we simply assume external financing to be constrained. However, we think of these constraints to be determined by the number of markets a firm operates in. This assumption intends to bring out most clearly the finding that external funding may be rationed and seems particularly relevant in localised markets as in transport or retailing where cross-subsidies from one local market to another are considered to play an important role. Although being obviously an indirect and imperfect indicator of “access to funds” the size in terms of market coverage is likely to matter in network industries since it is easily observable. In order to sharpen the view even further we may interpret market coverage in localised markets as being determined by the number of markets a firm operates in. This perspective is helpful in that it immediately induces an interesting question. If large firms can exploit their financial strength as a mean to deter entry, can they use their advantage in order to become even larger?

²³See for instance Bolton and Scharfstein (1990) or Hendel (1996).

4.1 A reduced form mm-entry game

As in the mm-entry game with reputation, we consider the strategic interaction of a multimarket firm that operates in $M - 1$ markets and considers entering market M in which a single-market firm is the incumbent. However, in order to abstract from the reputation effect and to concentrate on the long purse effect we only model the market in which the sm-firm is the incumbent and the mm-firm considers entry. In order to relate financial strength to the number of markets in which a firm operates, we assume that the mm-firm earns identical profits, $\pi_i > 0$, in each of the $M - 1$ markets where it is the incumbent. There is no (or equal) external funding for the two firms. Hence, both firms are financially constrained by the sum of profits in all markets they operate in, so that the single-market firm is more constrained than the multimarket firm. Benoit (1983 and 1984) investigates the case where the financially stronger firm is the incumbent. Here we analyse the reverse situation so that the financially stronger mm-firm considers entry in the market of the financially weaker sm-firm.

The structure of the entry game in market M is the same as in the reputation game. However, payoffs are now derived more explicitly analysing strategic interaction over time considering an infinite time horizon. The firms' per period payoffs depend on the state of competition: In a monopoly situation firms earn $\pi > 0$. If firms fight, they each lose $-\phi$, $\phi > 0$. If they acquiesce, they each gain $\psi \geq 0$. As in the reputation game, it is assumed that the firms gain more as monopolists than as duopolists: $\pi > \psi$. Firms discount at rate r , with $0 < r < 1$, and maximise the net present value of their expected income stream.

If the mm-entrant b stays out, the sm-incumbent a will remain a monopolist forever and earn monopoly profits, $\Pi_a = \sum_{t=0}^{\infty} r^t \pi$. If it enters, it is the sm-firm's move whether to stay, I , or to exit, O . If the sm-firm exits, the mm-firm will remain monopolist forever and earn monopoly profits, $\Pi_b = \Pi_a$. Alternatively, the sm-firm may choose to stay. In this case it is the mm-firm's decision whether to acquiesce, A , or to fight until the sm-firm will have to exit the market, F . Acquiescing yields $\Psi_a = \Psi_b = \sum_{t=0}^{\infty} r^t \psi$ for both firms. If the mm-firm chooses to fight, it will lose during the fighting periods and earn monopoly profits thereafter. The fighting periods are determined by the staying power of the firm which is financially more constrained and the willingness to fight. In our context the financial constraint is determined by the number of markets a firm operates in. Since by definition the sm-firm operates only in one market, the sm-firm is more constrained than the multimarket firm. If the mm-firm fights all periods, N_a , that the sm-firm can

sustain fighting, then the mm-firm's discounted profits are given by

$$\Phi_b = - \sum_{t=0}^{N_a} r^t \phi + \sum_{t=N_a+1}^{\infty} r^t \pi. \quad (6)$$

In this case sm-firm a 's payoff will be:

$$\Phi_a = - \frac{1 - r^{N_a}}{1 - r} \phi.$$

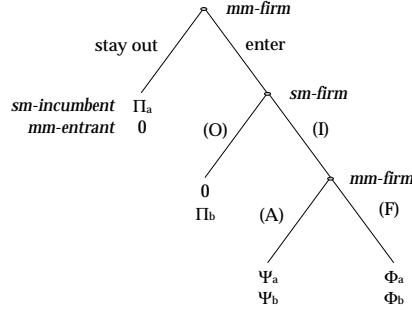


Figure 6: An incomplete capital markets game

The game, which is depicted in Figure 6, has two subgame perfect Nash equilibria depending on whether the number of periods, L_b , that the mm-firm is willing to fight is larger than the number of periods, N_a , that the sm-firm can sustain fighting. The “willingness to fight”, L_b , denotes the number of periods that mm-firm b would prefer fighting over acquiescing.²⁴

The willingness to fight L_b can be determined by setting equation (6) (given that the number of fighting periods is $L_b - 1$) equal to Ψ_b and solving for L_b :

$$\begin{aligned} \Phi_b &= \Psi_b \\ - \sum_{t=0}^{L_b-1} r^t \phi + \sum_{t=L_b}^{\infty} r^t \pi &= \sum_{t=0}^{\infty} r^t \psi \end{aligned}$$

²⁴Benoit (1983) has called L_b the “fighting incentive”. We amended his terminology in order to preserve the term “fighting incentive” for a more general interpretation (see section 3.2). Note that we assume that the discounted gain from a monopoly in later periods is at least large enough to motivate a fight of one period, i.e. $L_b > 1$.

$$\begin{aligned}
-\frac{1-r^{L_b}}{1-r}\phi + \frac{r^{L_b}}{1-r}\pi &= \frac{1}{1-r}\psi \\
L_b &= \frac{\ln(\phi + \psi) - \ln(\phi + \pi)}{\ln r}
\end{aligned}$$

Whenever the sm-firm's staying power is smaller than the mm-firm's willingness to fight, $N_a < L_b$, mm-firm b will choose to fight until the sm-firm exits in the last stage if sm-firm a stays in. Hence the only subgame perfect Nash equilibrium is that sm-firm a exits the market, yielding enter/ O/F as the equilibrium strategies.

Suppose now $N_a > L_b$. We would then have $\Psi_b < \Phi_b$ and analysing the post entry game yields the following Nash equilibria: O/F , O/A , I/A . However, as can be seen from the game tree, if we require equilibria to be subgame perfect, I/A is the only equilibrium outcome. This is because the sm-firm can anticipate that if it chooses I , the best response for mm-firm b is A . Taking this into account I is the better choice for the sm-firm.

In general, if the staying power of the sm-incumbent is smaller than the mm-entrant's willingness to fight, $N_a < L_b$, the mm-entrant has a strong fighting incentive and will successfully drive the sm-incumbent off the market without a fight.

4.2 Extensive form mm-entry games

The model outlined above is in a way trivial: if there is an incentive to fight longer than the incumbent can survive, predatory entry is a reasonable strategy. One of the main contributions of Benoit (1983) is to show that in a game with complete information and an infinite horizon, the financially weaker firm will not challenge the stronger firm even if the willingness to fight of the stronger firm is smaller than the staying power of the weaker firm.

His argument can be adapted to our mm-entry game. Consider an infinite-horizon game where the financially stronger entrant moves first and the incumbent is financially constrained. Despite the infinite horizon of the game as a whole, the argument relies on a backward induction. This technique can be employed since the number of periods in which the financially weaker firm is able to stay provides a finite starting point for the backward reasoning. Consider period N_a after $N_a - 1$ periods of fighting. If the financially stronger entrant decides to fight in this period the incumbent is forced to exit. Knowing this the entrant will fight as long as the willingness to fight is at least one period (note that we assume that the willingness to fight is independent from the number of fights that have occurred in the past). Anticipating this, the incumbent will exit the period before. Knowing this, the financially stronger entrant would be prepared to fight in period $N_a - 2$ provided that the willingness to fight is at least one period. This will again be anticipated by the

incumbent who will choose to exit the period before. This reasoning can be continued backward to the first period in which the incumbent will choose to exit. Hence, the result is independent of the relative strength of the willingness to fight and the staying power. Thus, independent of the number of periods the sm-firm could survive fighting if the mm-firm finds it profitable to fight no more than one period, the weaker firm would have to choose O .

Not surprisingly, Benoit has called this result a kind of “reverse chain-store paradox” (Benoit 1984, p. 492). Considering this outcome as “unrealistic” he introduces incomplete information about the type of weak firm: the strong firm does not know for sure whether it plays a game as described above or whether the weak firm will stick it out to the end no matter what. In this set up the financially stronger firm may be unable to deter the weaker firm. The probability that this is the case is an increasing function of the entrant’s staying power and a decreasing function of incumbent’s willingness to fight (see Benoit 1984, p. 496).

Given our approach to link the financial strength to the number of markets controlled, all versions of the financial strength models sketched suggest that if the difference in size is larger than a threshold, mm-firms have a fighting incentive and will threaten to use predatory behaviour in order to induce exit. Firms that operate in the same or a similar number of markets are not going to enter. Note that contrary to the results in the reputation models the long purse effect depends on relative size whereas in the reputation model an mm-firm has a strong fighting incentive if it controls a critical number of markets.

5 Results and stylised facts

Despite the popularity of reputation and long purse models in the theoretical literature, their use in applied work has been rare. In the introduction we noted a number of stylised facts with regard to structure, conduct and performance in some network industries with low sunk costs. Here we want to assess the explanatory value of the models developed above and reconsider some of the findings of the spatial competition models and the theory of contestable markets by referring to the example of the bus industry.

The spatial competition model entails the assumptions of one-bus operators that accommodate entry, reschedule and earn zero profits; all of which are clearly incompatible with observations (see stylised facts 4 and 5). The theory of contestable markets does require reactions lags which are not given (stylised fact 2) and fails to explain, first, why unprofitable post-entry competition occurred (stylised fact 5) and, second, why industry concentration increased (stylised fact 4). The models developed in this paper address these

shortcomings and provide at least partial explanations for most observations.

Why did firms almost never reschedule their departure times following entry of a competitor despite of the relatively small costs involved? Our reputation model provides a very intuitive answer. Consider every bus as serving a distinct market. If the incumbent relocates (acquiesces) in one market, potential entrants for other markets would conclude that the incumbent will relocate there too. Thus more entrants would follow so that profits in the entire network will be reduced. Hence, whenever the cost of fighting in one market is offset by the gains in the remaining markets, the incumbent will apply this strategy to the entire network - indeed to each single bus. Thus there is no incentive to relocate.²⁵ From this follows that the potential entrant will perceive a route or a network as being a natural monopoly although from a cost perspective this is only true for the operation of a single bus.

Why did we observe costly competition? In line with many models of predation under uncertainty, predation may occur in our model as a result of randomising strategies of players and the existence of tough players. Hence, we can explain the occasional occurrence of costly competition. Often, however, predation may not be observed but nevertheless play an important role as a barrier to entry or as a cause for exit or merger.

Why did large firms almost never enter markets of other large firms? Incumbents that operate in many markets have a strong fighting incentive and will fight to preserve their reputation. Thus tough and normal mm-entrants prefer to stay out.

Why did industry concentration increase, despite the lack of significant economies of scale or scope on the national level? The fact that in our model effective barriers to entry may exist if there is a strong fighting incentive combined with the finding that this fighting incentive depends on the number of markets a firm operates in, provides an explanation for the obvious strive to grow that was to be observed in the UK bus industry.²⁶

Altogether our findings have a simple policy implication. Do not rely on the absence of sunk costs when suggesting that competition will be effective. In multimarket industries a well functioning competition authority is required to maintain competition. Whether ex post competition inquiries

²⁵Other explanations why relocation did not occur may include: First, entrants may have come in at a full scale making relocation obsolete. Second, there may be a value to a simple pattern of departure times providing a disincentive to reschedule during parts of the day (take out one bus). Third, rescheduling may be more costly than obvious because of the requirement to either inform or lose passengers. Fourth, non-cooperative rescheduling is indeed difficult to achieve if there is no outright agreement.

²⁶However, the explanatory power of the model presented here may be limited regarding the operations of very small bus companies. Large bus companies may not find it worthwhile to predate very small operators in particular if this small operator runs a tendered (non-commercial) service during part of the day.

suffice to ensure effective competition is a matter for further investigation. An alternative is to organise competition for the market rather than in the market. In fact, this is the route many developed countries have taken. We believe for the wrong reason: market forces are able to ensure an integrated supply of local transport but they may fail to ensure effective competition.

The competition authorities in the UK allowed mergers in non contiguous markets, arguing that this would not impede potential competition which they expected from bus operators in contiguous markets. From the perspective of our analysis this approach is misguided. If the aggressive behaviour of a multimarket firm in one town can be observed by potential entrants in another town it may effectively deter entry in the latter.

6 Conclusion

In the theoretical literature predation models based on financial constraints or reputation have been popular. The research on reputation has shown that the general finding that reputation effects may have a significant impact on the equilibrium payoffs in repeated games is robust with regard to the number of players' types, the horizon of the game and many details regarding the informational structure (Fudenberg and Levine 1989, Schmidt 1993, Celentani et al. 1996). Our work distinguishes two types of players, we require equilibria to be perfect and, as a natural result of our sequencing, the horizon is finite. In this respect our work is much closer to the original framework of analysis used by MR and KW. This approach has several advantages. First, since we are explicit with respect to the structure of the game we can refer to a specific market in order to motivate our setup and compare our findings (in our case multimarket industries like bus services etc.). Second, we can use differing market games rather than repeat the same source game. As a result we can capture the reputation effects in the context of entry rather than entry deterrence. Third, although we do not in all constellations have a unique equilibrium outcome we find only one plausible PBE in each constellation given the payoffs and priors.

Table 1.:

Results for mm-firms with a strong fighting incentive

$(\beta_b > \bar{\beta}_b^{M-1}, \beta_a > \bar{\beta}_a^{N-1})$

<i>Entry constellation in M</i>	<i>PBE outcome</i>
sm-firm \rightarrow mm-firm	entry deterrence ²⁷
mm-firm \rightarrow sm-firm	predatory entry
mm-firm \rightarrow mm-firm	entry deterrence (“collusion”)

²⁷This result also holds if the mm-firm has a deterring fighting incentive, $\beta_b > \bar{\beta}_b^M$.

Table 1. summarises our main results. We believe that these have implications for applied as well as theoretical work. Using a sequencing, which we consider as more realistic, we strengthen the result of the traditional chain-store games that introduce uncertainty about the multimarket firm’s type. While in the traditional framework there are always some “last” markets where sm-firms enter with positive probability, in our setup no sm-firm will enter the market of an mm-firm in equilibrium if it controls a certain number of markets.

We find that both capital market imperfections and uncertainty about the opponents “type” can lead to an incentive for predatory entry which may operate alongside the well-established entry deterring effect of the threat of predation. Thus, being “large” leads to two advantages: it may deter rivals’ entry *and* it may allow predatory entry that drives out sm-firms without a fight. Seen in the context of market evolution both arguments imply a strong incentive to grow: on the one hand in order to lift local financial constraints by increasing the potential for internal financing (cross subsidising local markets) and, on the other, to make competitors believe that one is prepared to invest in a local fight in order to benefit from the reputation of being tough elsewhere.

This leads to a natural follow up question. If there is an incentive to grow and if predatory entry is one way of growing, why don’t large firms use this as a threat in order to buy small firms and thereby avoid investment in entry. Thus even if predation is not observed, it may explain a process of concentration through mergers and acquisitions in network industries. We believe that addressing this question more thoroughly is an interesting topic for future research.

Moreover, our results suggest that multimarket firms of a certain size will avoid entering each other’s patch. This leads to an interesting insight for the more general work on reputation effects with two long-lived players. The usual assumption is that two long-lived players interact in either one market for many periods or sequentially in many markets. Often results derived in this setup are either not very specific or not very robust with regard to the information structure of the game since firms may use complicated punishment strategies to enforce a certain behaviour of the rival. In our framework we get a simple collusion result without referring to complicated strategies.

Comparing the long-purse and the reputation effect, both support the same general findings. However there is one interesting difference. For given expectations regarding the various payoffs, the long purse model suggests that the fighting incentive depends on the relative size of firms. The reputation model on the other hand suggests that firms will avoid contesting an opponent’s local market as long as he controls a minimum of other markets

that make the investment in fighting for the “first” market worthwhile.

Since the three advantages of growing large, entry deterrence, potential predatory entry and collusion, are unlikely to create beneficial welfare effects, a post liberalisation process of concentration may imply a need for a more effective competition policy rather than a natural evolution to the most efficient market structure.

Appendix

If the mm-incumbent does not have a strong fighting incentive, we obtain the following result.

Proposition 5 *If $\beta_b > \bar{\beta}_b^{M-1}$ and $\beta_a \leq \bar{\beta}_a^{N-1}$, an mm-entrant will enter the market of any rival mm-firm that operates in less than \tilde{N} markets in a PBE of the generalised mm-entry game. The mm-incumbent will randomise between staying in, I , and exiting, O .*

Proof. By assumption the mm-entrant has a strong fighting incentive, $\beta_b > \bar{\beta}_b^{M-1}$ but the mm-incumbent not, $\beta_a \leq \bar{\beta}_a^{N-1}$. Knowing that the mm-entrant will fight with probability one, the mm-incumbent will not choose I with probability one. Choosing I yields an expected payoff in market N that is smaller than zero, $-\Phi_a$. Since tough mm-incumbents will always choose I there is no updating if normal mm-incumbents do so too. Hence, the expected payoff in the following market remains $(N-1)\Psi_a$ even if the mm-incumbents decides to stay in. Choosing O with probability one cannot be an equilibrium either. If this was the strategy, the sm-firms in later markets believe that the mm-incumbent is tough if he stays in. Thus a normal mm-incumbent could improve his payoff by choosing I . Thus in equilibrium the mm-incumbent will randomise and choose I with probability σ_a so that the sm-entrant in the next market randomises entry which in turn supports the randomising strategy in market N . Since

$$\sigma_a = \frac{\beta_a}{(1-\beta_a)} \left(\frac{1 - \bar{\beta}_a^{N-1}}{\bar{\beta}_a^{N-1}} \right)$$

this probability will approach one as N grows within the parameter space defined by $\beta_a \leq \bar{\beta}_a^{N-1}$.²⁸ Thus for high N tough and normal mm-entrants will not enter since the same argument applies as in the proof of Proposition 4. Below a critical level of N , \tilde{N} , both tough and normal mm-entrants will enter market M . More precisely, \tilde{N} is given by the N that yields

$$(M-1)\Pi_b = ((1-\beta_a)\sigma + \beta_a)(-\Phi_b + (M-1)\Pi_b) + (1-\beta_a)(1-\sigma)M\Pi_b$$

$$\begin{aligned} (M-1)\Pi_b = & \left((1-\beta_a) \frac{\beta_b}{(1-\beta_b)} \left(\frac{1}{\bar{\beta}^{N-1}} - 1 \right) + \beta_a \right) (-\Phi_b + (M-1)\Pi_b) \\ & + (1-\beta_a) \left(1 - \frac{\beta_b}{(1-\beta_b)} \left(\frac{1}{\bar{\beta}^{N-1}} - 1 \right) \right) M\Pi_b \end{aligned}$$

²⁸ $\beta_a \leq \bar{\beta}_a^{N-1}$ implies $\sigma_a \leq 1$.

$$\tilde{N} = \frac{1}{\ln \bar{\beta}} \ln \beta_b \bar{\beta} \frac{(\beta_a - 1) \Phi_b + (\beta_a - 1) \Pi_b}{(\beta_a - \beta_b) \Phi_b + (\beta_a - 1) \Pi_b}.$$

■

The Proposition derived above has one property that simplifies the analysis and leads to an equilibrium in pure entry strategies. Neither tough nor normal mm-entrants have an incentive to defect from a pooling equilibrium candidate with respect to the entry decision of the mm-firm.²⁹ In case the mm-entrant does not have a strong fighting incentive we do not necessarily obtain this property; rather mm-firms' entry behaviour must involve randomising.

Suppose the mm-entrant controls M markets so that $\beta_b < \bar{\beta}_b^M$ and the mm-incumbent has a strong fighting incentive, $\beta_a > \bar{\beta}_a^{N-1}$, and suppose both tough and normal mm-entrants would enter market M with probability one. This cannot be an equilibrium since the tough mm-entrant would prefer to stay out rather than spend $(-\Phi)$ on fighting in the first market, independent from the belief that the sm-firms in the remaining markets entertain when observing the mm-firm defecting.³⁰

Both staying out with probability one cannot be an equilibrium either. In this case the normal mm-entrant would prefer to enter since doing so will yield at least $M\Psi_b > (M-1)\Psi_b$. Again this result is independent from the belief that the sm-firms in M and the remaining markets entertain when observing the mm-firm defecting.

However, differing pure entry strategies cannot be an equilibrium either. Suppose the normal mm-firm will enter and a tough mm-entrant will stay out of market M with probability one. Knowing that it will have to fight in market M with probability one given that the sm-firm in this market will enter and knowing that staying out reveals that it is tough and thereby deter entry in markets $M-1, \dots, 1$ the tough mm-entrant prefers to stay out of market M since

$$-\Phi_b + (M-1)\Pi_b < (M-1)\Pi_b.$$

However, if so it cannot be optimal for the normal mm-firm to enter market M . Rather it would prefer to stay out, mimic the tough mm-firm and earn $(M-1)\Pi_b > M\Psi_b$. The same kind of argument applies if the normal mm-entrant considers to stay out.

Thus there can be no equilibrium in which a tough mm-firm plays a different pure entry strategy than the normal mm-firm. Since playing the

²⁹In traditional reputation models tough mm-firms would have an incentive to defect since normal mm-firms face, unplausibly, entry with positive probability in late periods.

³⁰Strictly speaking it is possible to assume out of equilibrium beliefs that ensure that both types choosing to enter market M is an equilibrium: if sm-firms believe that a mm-entrant that does not enter (a zero probability event) is normal, the tough mm-entrant may have no incentive not to enter the first market.

strategy of the tough mm-firm would “reveal” the tough firm, the normal firm would then prefer to imitate rather than play the differing strategy. In equilibrium mm-entrants will randomise entry.

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